

Amendments to the Claims

1. (Currently Amended): A method of forming a capacitor, comprising:

forming a first capacitor electrode over a semiconductor substrate;

forming a capacitor dielectric region onto the first capacitor electrode, the capacitor dielectric region comprising an exposed oxide-containing surface;

treating the exposed oxide-containing surface of the capacitor dielectric region with at least one of a borane or a silane without depositing any material onto the exposed oxide-containing surface; and

forming a second capacitor electrode over the treated oxide-containing surface, the second capacitor electrode comprising an inner metal surface contacting against the treated oxide-containing surface.

2. (Original): The method of claim 1 wherein the first capacitor electrode consists essentially of semiconductive material.

3. (Original): The method of claim 1 wherein the first capacitor electrode consists essentially of metal.

4. (Previously Presented): The method of claim 1 wherein the exposed oxide-containing surface comprises hafnium oxide.

5. (Previously Presented): The method of claim 1 wherein the exposed oxide-containing surface comprises aluminum oxide.

6. (Original): The method of claim 1 wherein the treating is with at least one borane.

7. (Original): The method of claim 6 wherein all borane used during the treating is void of halogen.

8. (Original): The method of claim 6 wherein the borane is selected from the group consisting of BH_3 , B_2H_6 , B_4H_{10} , B_5H_9 , B_6H_{10} and $\text{B}_{10}\text{H}_{14}$, and mixtures thereof.

9. (Original): The method of claim 1 wherein the treating is with at least one silane.

10. (Original): The method of claim 9 wherein all silane used during the treating is void of halogen.

11. (Original): The method of claim 9 wherein the silane is selected from the group consisting of SiH_4 , Si_2H_6 , Si_3H_8 and Si_4H_{10} , and mixtures thereof.

Claims 12-15 (Canceled).

16. (Original): The method of claim 1 wherein the treating comprises a temperature from 200°C to 500°C, and a pressure from 1 Torr to 100 Torr.

17. (Original): The method of claim 1 wherein the treating is for at least 1 second.

18. (Original): The method of claim 1 wherein the treating is for at least 10 seconds.

19. (Original): The method of claim 1 wherein the inner metal surface comprises an elemental metal or an alloy of elemental metals.

20. (Original): The method of claim 19 wherein the inner metal surface comprises tungsten.

21. (Original): The method of claim 1 wherein the inner metal surface comprises a conductive metal compound.

22. (Original): The method of claim 21 wherein the inner metal surface comprises TiN.

23. (Original): The method of claim 1 wherein the second capacitor electrode consists essentially of metal.

24. (Original): The method of claim 1 wherein the treating is effective to reduce leakage current of the capacitor than would otherwise occur in the absence of said treating.

25. (Previously Presented): The method of claim 1 wherein the exposed oxide-containing surface comprises OH groups, the treating being effective to passivate said OH groups.

26. (Previously Presented): The method of claim 1 wherein the depositing the second capacitor electrode comprises using a halogen-containing gas, the treating being effective to reduce halogen incorporation into the capacitor dielectric region than would otherwise occur in the absence of said treating.

27. (Currently Amended): ~~The method of claim 1 wherein,~~ A method of forming a capacitor, comprising:

forming a first capacitor electrode over a semiconductor substrate;

forming a capacitor dielectric region onto the first capacitor electrode,
the capacitor dielectric region comprising an exposed oxide-containing surface;

treating the exposed oxide-containing surface of the capacitor dielectric region with at least one of a borane or a silane;

forming a second capacitor electrode over the treated oxide-containing surface, the second capacitor electrode comprising an inner metal surface contacting against the treated oxide-containing surface;

wherein forming the capacitor dielectric region comprises deposition of multiple dielectric layers; and

intermediate at least some of the dielectric layer depositions; treating an outer surface of the capacitor dielectric region being formed with at least one of ~~a borane or a silane~~ the borane or the silane.

28. (Original): The method of claim 27 wherein the treating is with at least one borane.

29. (Original): The method of claim 27 wherein the treating is with at least one silane.

30. (Original): The method of claim 27 wherein the multiple dielectric layers comprise at least two different dielectric materials.

31. (Original): The method of claim 27 wherein the multiple dielectric layers are of the same dielectric material.

32. (Original): The method of claim 1 wherein the first capacitor electrode consists essentially of semiconductive material and the second capacitor electrode consists essentially of metal thereby forming an MIS capacitor.

33. (Original): The method of claim 1 wherein the first capacitor electrode consists essentially of metal and the second capacitor electrode consists essentially of metal thereby forming an MIM capacitor.

34. (Currently Amended): A method of forming a capacitor, comprising:

forming a first capacitor electrode over a semiconductor substrate;
forming a capacitor dielectric region onto the first capacitor electrode, the capacitor dielectric region comprising an exposed oxide-containing surface;

treating the exposed oxide-containing surface of the capacitor dielectric region with at least one of a borane or a silane at a temperature from 200°C to 500°C and a pressure from 1 Torr to 100 Torr for at least 1 second, ~~any layer deposited by the treating being no more than 3 monolayers thick~~ void of depositing any material onto the exposed oxide-containing surface; and

forming a second capacitor electrode consisting essentially of metal over the treated oxide-containing surface, the second capacitor electrode comprising an inner metal surface contacting against the treated oxide-containing surface.

35. (Previously Presented): The method of claim 34 wherein the exposed oxide-containing surface comprises hafnium oxide.

36. (Previously Presented): The method of claim 34 wherein the exposed oxide-containing surface comprises aluminum oxide.

37. (Original): The method of claim 34 wherein the treating is with at least one borane.

38. (Original): The method of claim 37 wherein all borane used during the treating is void of halogen.

39. (Original): The method of claim 37 wherein the borane is selected from the group consisting of BH_3 , B_2H_6 , B_4H_{10} , B_5H_9 , B_6H_{10} and $\text{B}_{10}\text{H}_{14}$, and mixtures thereof.

40. (Original): The method of claim 34 wherein the treating is with at least one silane.

41. (Original): The method of claim 40 wherein all silane used during the treating is void of halogen.

42. (Original): The method of claim 40 wherein the silane is selected from the group consisting of SiH_4 , Si_2H_6 , Si_3H_8 and Si_4H_{10} , and mixtures thereof.

Claim 43 (Canceled).

44. (Original): The method of claim 34 wherein the treating is for at least 10 seconds.

45. (Original): The method of claim 34 wherein the inner metal surface comprises an elemental metal or an alloy of elemental metals.

46. (Original): The method of claim 45 wherein the inner metal surface comprises tungsten.

47. (Original): The method of claim 34 wherein the inner metal surface comprises a conductive metal compound.

48. (Original): The method of claim 47 wherein the inner metal surface comprises TiN.

49. (Original): The method of claim 34 wherein the treating is effective to reduce leakage current of the capacitor than would otherwise occur in the absence of said treating.

50. (Previously Presented): The method of claim 34 wherein the exposed oxide-containing surface comprises OH groups, the treating being effective to passivate said OH groups.

51. (Previously Presented): The method of claim 34 wherein the depositing the second capacitor electrode comprises using a halogen-containing gas, the treating being effective to reduce halogen incorporation into the capacitor dielectric region than would otherwise occur in the absence of said treating.

52. (Currently Amended): ~~The method of claim 34 wherein,~~ A method of forming a capacitor, comprising:

forming a first capacitor electrode over a semiconductor substrate;

forming a capacitor dielectric region onto the first capacitor electrode,
the capacitor dielectric region comprising an exposed oxide-containing surface;

treating the exposed oxide-containing surface of the capacitor dielectric region with at least one of a borane or a silane at a temperature from 200°C to 500°C and a pressure from 1 Torr to 100 Torr for at least 1 second;

forming a second capacitor electrode consisting essentially of metal over the treated oxide-containing surface, the second capacitor electrode comprising an inner metal surface contacting against the treated oxide-containing surface;

wherein forming the capacitor dielectric region comprises deposition of multiple dielectric layers; and

intermediate at least some of the dielectric layer depositions, treating an outer surface of the capacitor dielectric region being formed with at least one of ~~a borane or a silane~~ the borane or the silane.

53. (Original): The method of claim 52 wherein the multiple dielectric layers comprise at least two different dielectric materials.

54. (Original): The method of claim 52 wherein the multiple dielectric layers are of the same dielectric material.

Claims 55-98 (Canceled).

99. (Currently Amended): A method of forming a capacitor, comprising:

forming a first capacitor electrode over a semiconductor substrate, the first capacitor electrode comprising an exposed metal surface;

treating the exposed metal surface of the first capacitor electrode with at least one of a borane or a silane;

forming a capacitor dielectric region onto the first capacitor electrode, the capacitor dielectric region comprising an oxide-containing surface received contacting against the treated metal surface of the first capacitor electrode, the capacitor dielectric region comprising an exposed oxide-containing surface;

treating the exposed oxide-containing surface of the capacitor dielectric region with at least one of a borane or a silane without depositing any material onto the exposed oxide-containing surface; and

forming a second capacitor electrode over the treated oxide-containing surface, the second capacitor electrode comprising an inner metal surface contacting against the treated oxide-containing surface.

100. (Currently Amended): A method of forming a capacitor, comprising:

forming a first capacitor electrode consisting essentially of metal over a semiconductor substrate, the first capacitor electrode comprising an exposed metal surface;

treating the exposed metal surface of the first capacitor electrode with at least one of a borane or a silane at a temperature from 200°C to 500°C and a pressure from 1 Torr to 100 Torr for at least 1 second, ~~any layer deposited by the treating being no more than 3 monolayers thick;~~

forming a capacitor dielectric region onto the first capacitor electrode, the capacitor dielectric region comprising an oxide-containing surface received contacting against the treated metal surface of the first capacitor electrode, the capacitor dielectric region comprising an exposed oxide-containing surface; ~~and~~

treating the exposed oxide-containing surface of the capacitor dielectric region with at least one of a borane or a silane at a temperature from 200°C to 500°C and a pressure from 1 Torr to 100 Torr for at least 1 second, ~~any layer deposited by the treating being no more than 3 monolayers thick~~ void of depositing any material onto the exposed oxide-containing surface; and

forming a second capacitor electrode consisting essentially of metal over the treated oxide-containing surface, the second capacitor electrode

comprising an inner metal surface contacting against the treated oxide-containing surface.

101. (New): A method of forming a capacitor, comprising:

forming a first capacitor electrode over a semiconductor substrate, the first capacitor electrode comprising an exposed metal surface;

treating the exposed metal surface of the first capacitor electrode with at least one of a borane or a silane;

forming a capacitor dielectric region onto the first capacitor electrode, the capacitor dielectric region comprising an oxide-containing surface received contacting against the treated metal surface of the first capacitor electrode, the capacitor dielectric region comprising an exposed oxide-containing surface;

treating the exposed oxide-containing surface of the capacitor dielectric region with at least one of a borane or a silane, said treating depositing a material onto the exposed oxide-containing surface, said material being of a thickness of only three monolayers or less; and

forming a second capacitor electrode onto the material, the second capacitor electrode comprising an inner metal surface contacting against the material.

102. (New): A method of forming a capacitor, comprising:

forming a first capacitor electrode consisting essentially of metal over a semiconductor substrate, the first capacitor electrode comprising an exposed metal surface;

treating the exposed metal surface of the first capacitor electrode with at least one of a borane or a silane at a temperature from 200°C to 500°C and a pressure from 1 Torr to 100 Torr for at least 1 second;

forming a capacitor dielectric region onto the first capacitor electrode, the capacitor dielectric region comprising an oxide-containing surface received contacting against the treated metal surface of the first capacitor electrode, the capacitor dielectric region comprising an exposed oxide-containing surface;

treating the exposed oxide-containing surface of the capacitor dielectric region with at least one of a borane or a silane at a temperature from 200°C to 500°C and a pressure from 1 Torr to 100 Torr for at least 1 second, said treating depositing a material onto the exposed oxide-containing surface, said material being of a thickness of only three monolayers or less; and

forming a second capacitor electrode consisting essentially of metal onto the material, the second capacitor electrode comprising an inner metal surface contacting against the material.

103. (New): A method of forming a capacitor, comprising:
forming a first capacitor electrode over a semiconductor substrate;
forming a capacitor dielectric region onto the first capacitor electrode,
the capacitor dielectric region comprising an exposed oxide-containing
surface;
treating the exposed oxide-containing surface of the capacitor
dielectric region with at least one of a borane or a silane, said treating
depositing a material onto the exposed oxide-containing surface, said
material being of a thickness of only three monolayers or less; and
forming a second capacitor electrode onto the material, the second
capacitor electrode comprising an inner metal surface contacting against the
material.

104. (New): The method of claim 103 wherein the exposed oxide-
containing surface comprises hafnium oxide.

105. (New): The method of claim 103 wherein the exposed oxide-
containing surface comprises aluminum oxide.

106. (New): The method of claim 103 wherein the treating is with
at least one borane.

107. (New): The method of claim 103 wherein the treating is with at least one silane.

108. (New): The method of claim 103 wherein the treating is effective to reduce leakage current of the capacitor than would otherwise occur in the absence of said treating.

109. (New): The method of claim 103 wherein the exposed oxide-containing surface comprises OH groups, the treating being effective to passivate said OH groups.

110. (New): The method of claim 103 wherein the depositing the second capacitor electrode comprises using a halogen-containing gas, the treating being effective to reduce halogen incorporation into the capacitor dielectric region than would otherwise occur in the absence of said treating.

111. (New): A method of forming a capacitor, comprising:
forming a first capacitor electrode over a semiconductor substrate;
forming a capacitor dielectric region onto the first capacitor electrode,
the capacitor dielectric region comprising an exposed oxide-containing
surface;
treating the exposed oxide-containing surface of the capacitor
dielectric region with at least one of a borane or a silane at a temperature
from 200°C to 500°C and a pressure from 1 Torr to 100 Torr for at
least 1 second, said treating depositing a material onto the exposed oxide-
containing surface, said material being of a thickness of only three
monolayers or less; and
forming a second capacitor electrode consisting essentially of metal
onto the material, the second capacitor electrode comprising an inner metal
surface contacting against the material.

112. (New): The method of claim 111 wherein the exposed oxide-
containing surface comprises hafnium oxide.

113. (New): The method of claim 111 wherein the exposed oxide-
containing surface comprises aluminum oxide.

114. (New): The method of claim 111 wherein the treating is with
at least one borane.

115. (New): The method of claim 111 wherein the treating is with at least one silane.

116. (New): The method of claim 111 wherein the treating is effective to reduce leakage current of the capacitor than would otherwise occur in the absence of said treating.

117. (New): The method of claim 111 wherein the exposed oxide-containing surface comprises OH groups, the treating being effective to passivate said OH groups.

118. (New): The method of claim 111 wherein the depositing the second capacitor electrode comprises using a halogen-containing gas, the treating being effective to reduce halogen incorporation into the capacitor dielectric region than would otherwise occur in the absence of said treating.

119. (New): A method of forming a capacitor, comprising:
forming a first capacitor electrode over a semiconductor substrate;
forming a capacitor dielectric region onto the first capacitor electrode,
the capacitor dielectric region comprising an exposed hafnium oxide-
containing surface;

treating the exposed hafnium oxide-containing surface of the capacitor
dielectric region with at least one of a borane or a silane; and
forming a second capacitor electrode over the treated hafnium oxide-
containing surface, the second capacitor electrode comprising an inner
metal surface contacting against the treated hafnium oxide-containing
surface.

120. (New): The method of claim 119 wherein the treating is with
at least one borane.

121. (New): The method of claim 119 wherein the treating is with
at least one silane.

122. (New): A method of forming a capacitor, comprising:
forming a first capacitor electrode over a semiconductor substrate;
forming a capacitor dielectric region onto the first capacitor electrode,
the capacitor dielectric region comprising an exposed aluminum oxide-
containing surface;
treating the exposed aluminum oxide-containing surface of the
capacitor dielectric region with at least one of a borane or a silane; and
forming a second capacitor electrode over the treated aluminum oxide-
containing surface, the second capacitor electrode comprising an inner
metal surface contacting against the treated aluminum oxide-containing
surface.

123. (New): The method of claim 122 wherein the treating is with
at least one borane.

124. (New): The method of claim 122 wherein the treating is with
at least one silane.

125. (New): The method of claim 1 wherein the treating is with at
least one borane and with at least one silane.

126. (New): The method of claim 34 wherein the treating is with
at least one borane and with at least one silane.

127. (New): The method of claim 103 wherein the treating is with at least one borane and with at least one silane.

128. (New): The method of claim 111 wherein the treating is with at least one borane and with at least one silane.

129. (New): A method of forming a capacitor, comprising:
forming a first capacitor electrode over a semiconductor substrate;
forming a capacitor dielectric region onto the first capacitor electrode, the capacitor dielectric region comprising an exposed oxide-containing surface;

treating the exposed oxide-containing surface of the capacitor dielectric region with at least one borane and with at least one silane; and

forming a second capacitor electrode over the treated oxide-containing surface, the second capacitor electrode comprising an inner metal surface contacting against the treated oxide-containing surface.